Journal of the Royal Society of Arts

NO. 4917 FRIDAY, 22ND JANUARY, 1954 VOL. CII

FORTHCOMING MEETINGS

WEDNESDAY, 27TH JANUARY, AT 2.30 p.m. '*Furnishing Fabrics of the Past 200 Years*', by Sir Ernest Goodale, C.B.E., M.C., Chairman and Managing Director, Messrs. Warner & Sons, Ltd. Professor A. E. Richardson, R.A., F.R.I.B.A., a member of Council of the Society, will preside. The paper will be illustrated with examples of fabrics.

WEDNESDAY, 3RD FEBRUARY, AT 2.30 p.m. '*The Evolution of Public Health Engineering*', by F. E. Bruce, M.Sc., S.M., A.M.I.C.E., Reader in Public Health Engineering, Imperial College of Science and Technology. G. M. McNaughton, C.B., B.Sc., M.I.C.E., Chief Engineer, Ministry of Housing and Local Government, will preside. The paper will be illustrated with lantern slides.

TUESDAY, 9TH FEBRUARY, AT 7.30 p.m. FILM EVENING. (See special notice.)

WEDNESDAY, 10TH FEBRUARY, AT 2.30 p.m. '*Shops and Shopping in the Past Two Centuries*', by Professor A. E. Richardson, R.A., F.R.I.B.A. The Right Honble. the Earl of Rosse, M.B.E., F.S.A., Chairman, The Georgian Group, will preside. The paper will be illustrated with lantern slides.

WEDNESDAY, 17TH FEBRUARY, AT 2.30 p.m. FERNHURST LECTURE. '*Modern Developments in Fungicide Research*', by R. W. Marsh, M.A., Mycologist, Long Ashton Research Station. J. Ramsbottom, O.B.E., M.A., D.Sc., will preside.

AWARD OF SWINEY PRIZE

The Swiney Prize for 1954 has been awarded, on the recommendation of a Joint Committee of the Royal Society of Arts and the Royal College of Physicians, to Professor G. W. Paton, B.C.L., M.A., Vice-Chancellor of the University of Melbourne, for his *Textbook of Jurisprudence* (Second Edition).

Eleven entries were received for the prize and the judges were Sir Carleton Allen, M.C., Q.C., M.A., D.C.L., and H. G. Hanbury, D.C.L., Vinerian

Professor of English Law, Oxford. It is interesting to note that Sir Carleton Allen himself won the Swiney Prize in 1944.

The prize, which consists of a silver cup and money to the total value of £200, is awarded on every fifth anniversary of the testator's death. It is offered alternately for medical and legal jurisprudence.

FILM EVENING

The third Film Evening of the Session will be held on Tuesday, 9th February, at 7.30 p.m., and the programme will consist of the following two films: *Powered Flight* and *The Heart is Highland.*

Tickets of admission are not required and Fellows are entitled to introduce two guests. Light refreshments will be served in the Library afterwards at a charge of one shilling per head.

Powered Flight (55 minutes) is a cinematographic tribute on the jubilee of the first flight by the Wright brothers. It was produced by the Shell Film Unit in co-operation with the Royal Aeronautical Society, and with the technical advice of a strong committee under the leadership of Mr. Peter Masefield. It is entirely composed of authentic material, including occasional shots illustrating the contemporary scene as a background to flight. The film will be introduced by Mr. Peter Masefield.

The Heart is Highland (20 minutes) is a Technicolor film produced by British Transport Films and shows some of the aspects of life in the Highlands to-day, linking present developments in industry, agriculture and transport with the country's past. The film will be introduced by Mr. Edgar Anstey, Films Officer to the British Transport Commission.

MEETING OF COUNCIL

A meeting of Council was held on Monday, 11th January, 1954. Present: Mr. E. Munro Runtz (in the Chair); Sir Alfred Bossom; Sir Frank Brown; Sir Edward Crowe; Sir John Forsdyke; Mr. P. A. Le Neve Foster; Mr. A. C. Hartley; Dame Caroline Haslett; Dr. R. W. Holland; Sir Harry Lindsay; Mr. G. K. Menzies; Sir Francis Meynell; Mr. J. A. Milne; Mr. O. P. Milne; Sir William Ogg; Mr. E. M. Rich; Professor A. E. Richardson; Mr. A. R. N. Roberts; Mr. Gordon Russell; Sir Harold Saunders; Sir Selwyn Selwyn-Clarke; Sir John Simonsen, and Mr. William Will; with Mr. K. W. Luckhurst (Secretary) and Mr. R. V. C. Cleveland-Stevens (Assistant Secretary).

ELECTIONS

The following candidates were duly elected Fellows of the Society:

Abidin, Syed Zainal, Alor Star, Malaya.
Bishop, Marcus, Hull, Yorks.

Burl, Harry Aubrey Woodruff, Wigston Magna, Leics.
Caspari, Peter, F.R.I.B.A., M.R.A.I.C., Toronto, Ontario, Canada.
Chatterji, Ushanath N., D.Phil., D.Sc., New Delhi, India.
Coleclough, Frederick Thomas, A.T.D., Cullingworth, Yorks.
Crehan, Mark Vincent, M.A., Westcliff-on-Sea, Essex.
Dickson, Arthur James, O.B.E., M.I.C.E., Auckland, New Zealand.
Dixon, Norris Hepworth, A.S.A.A., Solihull, Warwicks.
Dwyer, Thomas Bernard, Bristol.
Eates, Kenneth Raye, M.B.E., Karachi, Pakistan.
Exley, Derrick, Cudworth, Yorks.
Ferguson, Edgar Allan, A.C.I.S., Brisbane, Queensland, Australia.
Foss, Hugh Rose, O.B.E., Sevenoaks, Kent.
Foster, Bernard, M.P.S., Cottingham, Yorks.
Graham, Gordon, A.R.I.B.A., West Bridgeford, Nottingham.
Gray, The Rev. Douglas Bramwell, London.
Hall, Mrs. Margaret Priscilla, London.
Harcourt-Robinson, William Gaythwaite, B.A., B.Sc., London.
Hargreaves, Thomas H., A.R.I.B.A., Preston, Lancs.
Hearn, Richard Lankaster, B.A.Sc., M.E.I.C., Queenston, Ontario, Canada.
Hornblow, Frederick Horace Frank, Khartoum, Sudan.
Hubbard, Thomas Leslie Wallan, Wallington, Surrey.
Johnson, Alan Garfield, Horbury, Yorks.
Johnson, Stanley, A.C.A., Singapore.
Kearney, Elfric Wells Chalmers, M.I.Struct.E., Burgh Heath, Surrey.
Kerling, Miss Nelly Johanna Martina, Ph.D., London.
Lang, William Warner, A.M., Wellesley, Massachusetts, U.S.A.
Larter, Dennis St. Clair, Colchester, Essex.
Lawton, Frederic Lewis, B.A.Sc., Westmount, Quebec, Canada.
Light, Horace Robert, B.Sc., F.C.I.S., Godalming, Surrey.
Lyons, Simon Manuel, Barrow-in-Furness, Lancs.
Macdonald, Alexander Ranald Hume, M.A., London.
Macnaghten, Robin Donnelly, B.A., Littlehampton, Sussex.
Magnus, Joseph Lazareck, Rickmansworth, Herts.
McCormick, John, Oldham, Lancs.
Morcombe, William George, Portsmouth, Hants.
Morgan, Desmond, Port Elizabeth, South Africa.
Nathan, The Hon. Roger Carol Michael, M.A., London.
Newman, Bernard, Harrow, Middx.
Nosworthy, Sir Richard Lysle, K.C.M.G., Richmond, Surrey.
Ozouf, Leonard Charles, Stafford.
Palmer, Brigadier Godfrey Vaughan, C.B.E., T.D., Hoo, Kent.
Pembrey, Miss Dorothy Kathleen, Steyning, Sussex.
Prince, Wilfred Edward, Manchester.
Quick, Captain James Harrison, O.B.E., Wembley Park, Middx.
Robertson, Robert James, Castlemaine, Victoria, Australia.
Russell, Ben Harold, London.
Shennan, Sir Alfred Ernest, M.A., F.R.I.B.A., J.P., Liverpool.
Smail, William, A.M.I.Mech.E., A.I.E.E., Markinch, Fife.
Smith, William, Willenhall, Staffs.
Sondhi, Jagdish Raj, B.E., Mombasa, Kenya, East Africa.
Solberg, Nils Landmark, Durban North, Natal, South Africa.
Stone, Edgar Jocelyn, Toronto, Ontario, Canada.
Sturrock, Frederick Lamond, A.R.I.B.A., Constantia, Cape, South Africa.
Swindells, Norman, M.A., Ph.D., Solihull, Warwicks.

Turner, Arthur George, Oatley, New South Wales, Australia.
Turner, John Theodore Howard, M.Sc., D.I.C., A.C.G.I., Epsom, Surrey.
Veal, Frederick, Manchester.
Walker, William James, Southsea, Hants.
Watson, Professor Wilfred, M.A., Ph.D., Calgary, Alberta, Canada.
Wilkinson, Thomas Gilbert Alvyn, M.A., Berkeley, California, U.S.A.
Williams, Robert Charles Gooding, B.Sc., Ph.D., D.I.C., A.C.G.I., Guildford, Surrey.
Wright, Albert Ernest, O.B.E., B.A., Karachi, Pakistan.
Wye, William Henry, A.R.I.B.A., London.
Young, Frederick George, E.D., M.A., Calgary, Alberta, Canada.

The following candidate was duly elected an Associate Member of the Society:

Graves, James Edward, Maryport, Cumberland.

The following was admitted under Bye-Law 66:

The Andersonian Library, Royal Technical College, Glasgow.

SWINEY PRIZE

Dr. R. W. Holland, Mr. E. Munro Runtz and Sir Selwyn Selwyn-Clarke were appointed to represent the Society at a joint meeting with the representatives of the Royal College of Physicians, for the purpose of making the award of the Swiney Prize, 1954.

LIBRARY

It was agreed to authorize the appointment for one year for an additional Library Assistant for special work in connection with the Society's archives.

ARCHITECTURAL EDUCATION

Sir Alfred Bossom and Mr. O. P. Milne were re-elected the Society's representatives on the Boards of Architectural Association for the Royal Institute of British Architects and the Architects Registration Council respectively.

OTHER BUSINESS

A quantity of formal and financial business was transacted.

STEREO-CINEMATOGRAPHY

A paper by

LESLIE KNOPP, Ph.D., M.Sc., F.R.P.S., Hon.F.B.K.S.

Technical Adviser, Cinematograph Exhibitors' Association of Great Britain and Ireland, read to the Society on Wednesday, 13th January, 1954, with Sir Henry French, G.B.E., K.C.B., Director-General, British Film Producers Association, in the Chair

THE CHAIRMAN: Our lecturer, Dr. Leslie Knopp, was appointed Technical Adviser to the Cinematograph Exhibitors' Association in 1936. The film industry, like many other industries, is divided into different sections. In most industries they use the terms manufacturers, wholesalers and retailers. For some reason or other we use different terms, but they mean broadly the same thing. We say producers, distributors and exhibitors. As I have said, Dr. Knopp is employed by the exhibitors' trade association. In this industry, as in many other industries, the different sections do not always see eye to eye, but there are some things on which we are in complete agreement. One of them is Dr. Knopp. We all recognize him as being a man of great knowledge, of sound judgment in all matters affecting scientific and technical issues, and, perhaps above everything else, we know he is a man of absolute integrity.

I hope I may be forgiven if I suggest to the members of this distinguished audience two thoughts that might be in their minds as they listen to the lecture. The first is very relevant to what I have already said about our lecturer. As you listen to him you will, I am sure, share my view that for all practical purposes he might be the adviser of the whole industry, and not merely the adviser of one section. The second is rather different. It is this: many people—I do not mean members of this audience—think of the cinema and of films as merely means of providing entertainment. Of course, films are very much more than that. Films are becoming more and more valuable as an aid to teaching people, from the youngest right up to post-graduates engaged in research work; and many of you must know that during the war years films proved themselves to be quite invaluable as a means of teaching and training military personnel and many other men and women who were engaged in war work.

Developments in the art of making and projecting films will, in the future, prove to be of more value to teaching and research than to entertainment.

The following paper, which was illustrated with lantern slides, was then read:

THE PAPER

Rather more than one hundred years ago, Sir David Brewster, F.R.S., one of the leading scientists of his time, delivered to this Society a lecture upon stereoscopy—a subject which was then becoming popular, and one upon which he had devoted many years of study. The subject, however, was not a new one: indeed, Euclid defined the basic requirements for stereoscopic vision and this definition remains to-day as true and accurate as when it was written about 2,000 years ago. Throughout the ages, several scientists, physiologists

and artists have studied and have written treatises upon the principles involved in stereoscopy and binocular vision.*

To make stereographic drawings is difficult and laborious, and it is not surprising that few artists or draughtsmen have undertaken the task; but about the time of Sir David Brewster's lecture, when the newly discovered technique of photography—hitherto a scientific novelty—was beginning to enjoy a wider and more general application, it was quickly recognized that photographic images provided easy and ready means of making stereograms. In 1849, Duboscq was already making binocular daguerreotypes and selling to the public stereoscopes with lenses, by which they might be viewed. Stereoscopic photographs enjoyed a wide popularity, and the stereoscope sometimes became an important piece of furniture in the Victorian drawing-room. But interest in this art-form has waned, although recently, with the more general use of photographic colour transparencies, there has been a slight revival.

The pioneers of cinematography have each in their turn applied their attention to stereoscopy. Both Friese-Green and Paul carried out some promising experiments about forty years ago but, probably due to financial considerations, were unable to make much headway.

At the Festival of Britain, three-dimensional pictures were exhibited at the Telecinema and, I believe, were well received by the public, but for many years the motion picture industry both in this country and in America evinced little or no interest in the stereoscopic form.

During the past eighteen months or so, there has been a sudden change. No doubt because of the serious recession in cinema attendances, particularly in America, the Hollywood film producers seized upon the three-dimensional film as a means of re-attracting the public. But due probably to their haste and over-eagerness, their first productions, although financially successful, were unfortunate and disappointing examples of the art and technique of stereo-cinematography.

If the object of stereo-cinematography is to present to the eyes of the observer images which are identical to and correspond with those received in the real world, let me inform you at once that the object is incapable of attainment. This, however, is not to say that the three-dimensional film is incapable of presenting a high degree of realism; indeed, if the medium is skilfully handled with a full knowledge of its inherent limitations, a satisfactory and pleasing reproduction of the real world can be presented. But if, in making or subsequently projecting our film record, we proceed ignorantly or in disregard of these limitations, our reproduction will contain gross and unpleasant distortions and perhaps cause our audience to suffer discomfort from visual fatigue, eye strain and headache.

In the real world we are able to perceive the solidity of objects and their relative position in space because the brain is able to integrate and interpret the information received by each of our two eyes. The integration is carried out

* Leonardo da Vinci in *Trattato della Pittura Scultura ed Architettura* (1584) deals with the principle of binocular vision. See also Anguilonius' essay on *Optics* (1613) and Poggendorf's *Annalen*.

by our very complex optico-nervous systems, and our interpretation and judgment of the information results from the co-ordination of our sensory experiences. Much of this information, however, is common to both monocular and binocular vision, and this probably accounts for the fact that the graphic arts have been acceptable to mankind throughout the ages. But, for the more accurate perception of space relationship, and particularly of near objects, binocular vision is necessary. The eyes, due to their separation,* receive dissimilar images. Subconsciously, the optical axes of the eyes converge upon the object of interest at which they are looking and, at the same time, the lens systems of the two eyes accommodate themselves to the distance of the object, so that the image of the object falling upon the fovea is in sharp focus.

In any system of stereoscopic reproduction there are two basic requirements which must be satisfied. First, we must present to each eye separate and dissimilar images; that is to say, we must present to the left eye a 'left-eye' image separate from and dissimilar to a 'right-eye' image, which we must present only to the right eye. Secondly, the relative positions of objects represented in the images must be such that the eyes will converge upon them as they would do if they were looking at real objects.

The accommodation or the adjustment of the focus of the lens system of the eyes is necessary for both monocular and binocular vision. It is, however, a requirement that cannot satisfactorily be met in any stereographic system, and particularly in stereo-cinematography where we are invariably using small photographic images and, in projecting them upon a screen, magnifying them so that they may be viewed simultaneously by a large audience. It will readily be understood that every person in the audience must focus his eyes upon the images on the screen and, at the same time, his eyes must converge upon the *apparent* position of those images in space which may be in front of or beyond the plane of the screen. Hence, every member of the audience is performing an optical evolution which he is not called upon to perform in the real world. In the real world, the eyes converge upon and accommodate their focal length to suit the distance from each object in the scene; but in viewing stereo-motion pictures, the accommodation of the focal length of the eyes remains fixed for each member of the audience, according to his distance from the screen and irrespective of the apparent position of the objects observed.

There is a correct distance at which any photographic image should be viewed. Figure 1 shows the image of an object falling upon the retina of the eye and upon a photographic plate set in a camera. If a transparency is made from the plate and is set before the eye of an observer at a distance equal to the focal length of the camera lens (f_c) so that the angles of the object and of the photographic image subtending the eye are the same, the image received by the eye will be the same in both cases. The viewing distance (D) of the object will be:

$$D = f_c \frac{w_o}{w_i}$$

where w_o is the width of the object and w_i is the width of the photographic image.

* The interocular spacing varies between 63mm. and 65mm.

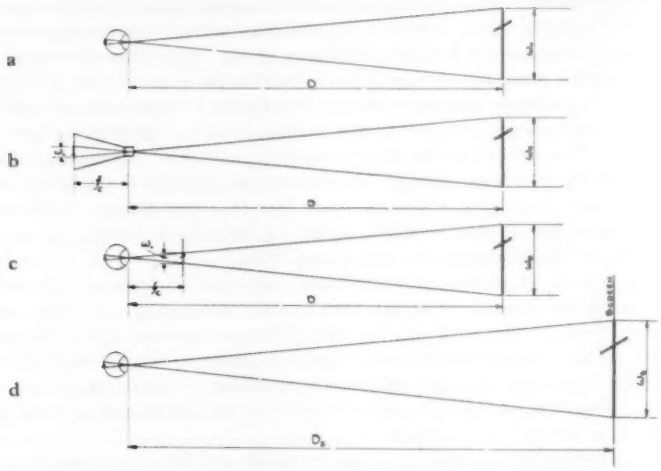


FIGURE 1 (a) *An eye viewing an object of width w_o from a distance D.*
(b) *A camera taking a photograph of the same object from the same distance. The camera has a focal length of f_c, and the width of the photographic image of the object is w_i.*
(c) *The eye viewing the photographic image. If the latter is placed a distance of f_c from the eye, the image falling upon the retina will be the same as in* (a). *The correct viewing distance of contact-printed stereograms is f_c.*
(d) *If the photographic image is projected upon a screen so that its width is now w_s, and if the image falling upon the retina is to be the same, then D_s is the correct viewing distance.*

$$D_s = f \frac{w_s}{w_i}$$

or $$D_s = f_c m$$

where m is the number of times the photographic image is magnified on the screen.

If, however, we project on to a screen a greatly magnified image of our photograph, so that its width is now w_s, it can be seen in correct proportion only if the angle of the magnified image subtending the eye remains the same. If the correct viewing distance from the screen is D_s, it will be seen that

$$D_s = f_c \frac{w_s}{w_i}$$

and since $\frac{w_s}{w_i}$ is the magnification factor (m) of our photographic image, we can state that the correct viewing distance from the screen is

$$D_s = f_c m$$

In viewing any two-dimensional picture the distance D_s can vary within fairly wide limits without occasioning discomfort or fatigue to the observers,

but with any form of stereoscopic presentation, the relationship becomes one of importance.

Figure 2a shows in plan view a cube viewed by two eyes, the two photographic images L_i and R_i set at a distance f_c from the eyes. Figure 2b shows these photographic images greatly magnified and projected upon a screen. The corners of the cube A and B, seen by the right eye, will fall upon the screen at RA and RB respectively, and similarly the corners C and D, seen by the left eye, will fall upon the screen at LC and LD. Now, if the observer is at his correct viewing distance from the screen (D_s), he will find it impossible to converge his eyes on points A, B, C and D, which represent the true position of the cube and, at the same time, focus them on points RA, RB and LC, LD on the screen, which are the screen images of these points. He will experience a breakdown of his optical mechanism.

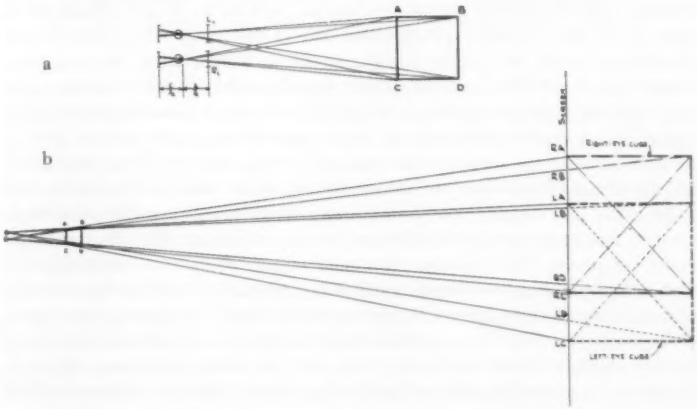


FIGURE 2 (a) *The correct distance of the eyes (f_c) from the stereograms L_i and R_i for viewing the cube ABCD.* (b) *The two stereograms projected upon a screen. The eyes cannot converge upon the true position of the cube ABCD and at the same time accommodate their focal length to bring into focus the homologous image points on the screen.*

From this illustration it will be appreciated that as we increase the magnification of our photographic image, so does our screen recede into the scene. The position of objects in a scene and our factors of magnification are limited by the physiological tolerances of the convergence-accommodation mechanism of the human eyes.

The 35mm. film, which has been standardized throughout the world for cinema use, carries photographic images which measure 0.825 in. by 0.6 in. These require to be magnified some two to four hundred times to fill the screens fitted in normal cinemas, and practical considerations do not permit a reduction of these magnification factors; indeed, the present-day tendency is to increase

their size and not to reduce it. Consequently, it is necessary for the technician to find means whereby magnifications of this order may be used without causing a breakdown of visual co-ordination. Of course, the obvious solution would be to arrange every scene so that the nearest object to be photographed is not less than 50 or 60 feet from the camera; this distance, being, probably, about one half the length of the auditorium of the average cinema, can be regarded as an average viewing distance.

It seems, however, that close-ups, portraits taken at short range, enhance the attractiveness and glamour of film stars and it is feared that neither the film producers nor the general public would agree to this solution. But ophthalmologists and technologists are not yet agreed on the distances at which the apparent position of objects may appear in front of the plane of the screen without causing eye strain or fatigue. It has been suggested,* although the argument contains a fallacy, that the average pair of eyes can see over an arc of 90° without movement of the head. A point 45° on either side of the centre which has the same convergence angle as a point straight ahead, is distant from the eyes about 70 per cent of the distance to the point straight ahead; and thus about 30 per cent variation of the accommodation-convergence ratio is encountered in normal vision. Others consider that objects may appear to be 50 per cent or more of the distance from the screen to the observer without causing visual discomfort; this distance has been adopted arbitrarily by technicians in this country and in America, but it seems that much more thought and experiment must be given to this important aspect if the stereo-motion picture is to be freed from public complaint. The 'nearness factor' of objects needs to be determined in relation to the shortest viewing distances and particularly—and this aspect has not been investigated thoroughly—in relation to the velocity of moving near objects.

There are, however, three methods by which the camera operator can control the reproduction of the depth of a scene and, in effect, cause near objects to appear close to or at the plane of the viewing screen. The first of these methods is to photograph the scene with cameras having a distance between their lenses less than the interocular spacing of the human eyes. If, as in Figure 3, a pair of stereographs are taken of the cube ABCD with cameras having a distance I_c between the lenses† and the photographic images are subsequently projected

* Prof. J. T. Rule: *Journal of the Optical Society of America*, 1941.

† The separation of camera lenses is given by the following formula:

$$I_c = \frac{w_i I_e (D_c - f_c)}{w_g f_c}$$

where I_c = Camera lens inter-axial
I_e = Human interocular
w_i = Width of photographic image
w_g = Width of screen image
D_c = Distance of camera lens to object which is to be in the plane of the screen
f_c = Focal length of camera lens.

If lenses of long focal length are not used, or very near objects are not to be photographed, the value of f_c with respect to D_c is small, and the formula may be simplified to:

$$I_c = \frac{w_i I_e D_c}{w_g f_c}$$

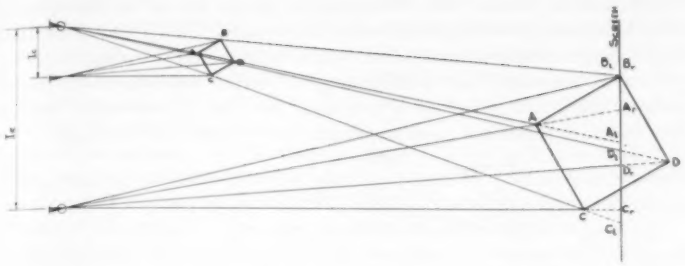


FIGURE 3: *A near object can be projected on to, and brought to the plane of a viewing screen by using an interaxial spacing between the camera lens that is less than the spacing between the eyes*

upon a screen, to an observer with an interocular of I_e, the cube will appear to be substantially in the plane of the screen. Corner B of the cube will appear to be at the screen because B_l and B_r (respectively the left and right eye images of B) are coincident at the screen. Corners A and C will appear to be in front of the screen because the homologous image points, A_l and A_r and C_l and C_r respectively, form crossed or negative parallaxes. Corner D will appear immediately behind the screen because the homologous points D_l and D_r are in positive parallax.

The use of the variable camera lens spacing system is, in general, satisfactory, but there are limitations: when a lens inter-axial less than the human interocular is used, the depth of the scene is necessarily compressed. The differences of the convergence angles between the front and back of small solid objects at a small distance are much greater than the differences of the convergence angles of a similar but much larger object viewed from proportionally greater distances. Consequently, there is a loss in the perception of depth in stereoscopic magnification and, if this latter is great enough, the convergence angles may be reduced below the ability of the eye to resolve them and a flat picture will result. In this respect, stereoscopic magnification differs from the magnification of a two-dimensional photograph inasmuch as the latter is always interpreted as an object viewed at a short distance. For instance, on a normal cinema screen the head of an artist in a close-up photograph may be ten feet in height, but it is interpreted and accepted as a view of a normal head at close range. With stereoscopic magnification, however, the image is that of a ten-foot head—that is, the head of an eighty-foot giant! When the size of the objects is known, most observers accept the enlargement and it passes unnoticed unless their attention is drawn to it, but others, with more discriminating visual acuity, find this phenomenon of giantism objectionable and a source of annoyance. It is interesting to note that when the size of the object photographed is not known, it is always interpreted as being of giant size when stereoscopically magnified.

The converse is also true. When distant objects are to be photographed a lens separation greater than interocular can be used. This produces the effect of increasing the apparent depth sense, but, at the same time, dwarfing the scene.*

It may be mentioned that, in discussing the recently exhibited stereo-motion pictures, many film reviewers commented upon the objectionable dwarfing effect in distant scenes but made no comment on the giant-like close-ups.

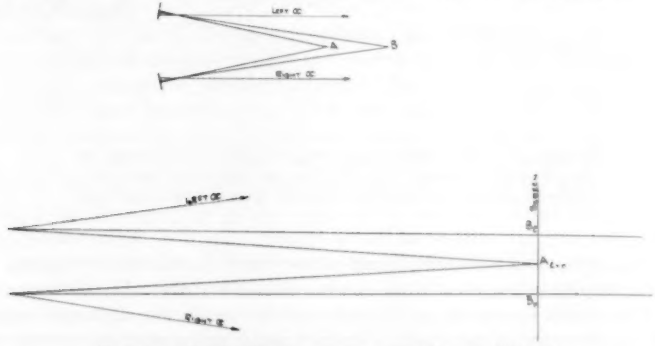


FIGURE 4 (top) *Stereo cameras converging on object A.* (bottom) *The photographic images projected upon a screen so that A is in the plane of the screen. If the distance between B_l and B_r, the homologous image points of object B, which is a little beyond A, is equal to the human interocular, object B will appear to be at infinity*

The second method of controlling depth in stereoscopic photography is to converge the optical axes of the camera lens on the near object which it is desired to place in the plane of the viewing screen. The system, which is shown in Figure 4, has serious disadvantages and can introduce gross distortion of depth. If A is the object which is to appear in the plane of the scene, the cameras are positioned so that their optical axes pass through object A. When projected, the stereo images of A will be co-incident at the screen, and therefore the object will appear to be in the plane of the screen. But the homologous points of object B, which is only slightly beyond A, will appear on the screen at B_l and B_r respectively. Irrespective of the magnification factor of the screen image, the distance between the points B_l and B_r cannot be greater than the interocular distance of the observer, namely $2\frac{1}{2}$ ins. approximately. If the distance between the points is equal to the interocular, point B will appear to be at infinity, and thus the distance from A to B, which may be a few feet

* The formula often used to determine the inter-axial spacing of camera lenses when photographing distant objects is given by:

$$I_c = \frac{D.d}{50\,(D - d)}$$

Where D = distance to the most distant object
d = distance to the nearest object
I_c = camera inter-axial.

in the original scene, will be exaggerated to the observer as the distance from the plane of the screen to infinity. This system, therefore, imposes severe restrictions upon the depth of scenes. In addition, there is an angular displacement between the planes of the stereo images which introduces lateral distortions. When magnified some hundreds of times, these distortions will frequently exceed the ability of the eyes to accommodate them.

The third method seeks to minimize these difficulties. Whilst keeping the stereo images in the same plane and the optical axes of the camera lens parallel, the inter-axial distance between the lens is varied to suit the distance of the near object which it is desired shall appear in the plane of the screen (Figure 5).

Although this method reduces lateral distortion, it nevertheless restricts the depth of scenes that may be photographed.

It is, perhaps, appropriate to consider some of the practical means that have been used for taking stereo-motion pictures. Quite naturally, the first efforts were directed towards getting the two stereo images side by side on the same film, and thus using only one camera. An early method was to employ a 'beam-splitter' unit in front of the camera lens. This comprises two pairs of prisms or mirrors. The mirrors in one pair are set at right-angles to one another with their mirrored surfaces facing outwards in opposite directions, and with the edges nearest the camera lens touching one another. The mirrors are positioned so that they are symmetrical to and are at an angle of 45° to the optical axis of the camera lens. The second pair of mirrors are also positioned symmetrically to and at an angle of 45° to the optical axis of the camera lens, but with the mirrored faces turned inwards. The outer mirrors reflect a left- and right-eye image respectively on to the inner mirrors, and from thence, through the lens

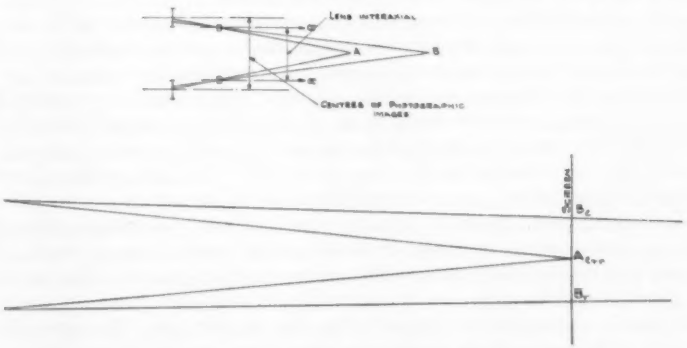


FIGURE 5 (top) *A reduction of the lens inter-axial in relation to the centres of the photographic plates or films for the purpose of photographing the near object A.* (bottom) *The photographic images projected upon a screen so that A is in the plane of the screen. If the distance between B_L and B_R, the homologous image points of object B, which is a little beyond A, is equal to the human interocular, object B will appear to be at infinity*

on to the film. The distance between the centres of the outer mirrors is the equivalent to the inter-axial spacing of the stereo-images. This spacing and also the angles at which the mirrors are set can be adjusted to suit the depth of the scene or the distance at which the objects are to be photographed. Although the system can give results that may please the amateur, it is unsatisfactory for professional use because the area of the images is reduced by one quarter and the subsequent magnification factor must be increased. Excessive magnification not only affects stereoscopic reproduction, but introduces other adverse factors such as loss of definition, graininess of image and lack of screen luminance. The system also introduces a reversal of the images, that is, the right-eye image is on the left-hand side of the film; although this can be corrected in the subsequent printing operations, it is an added complexity.

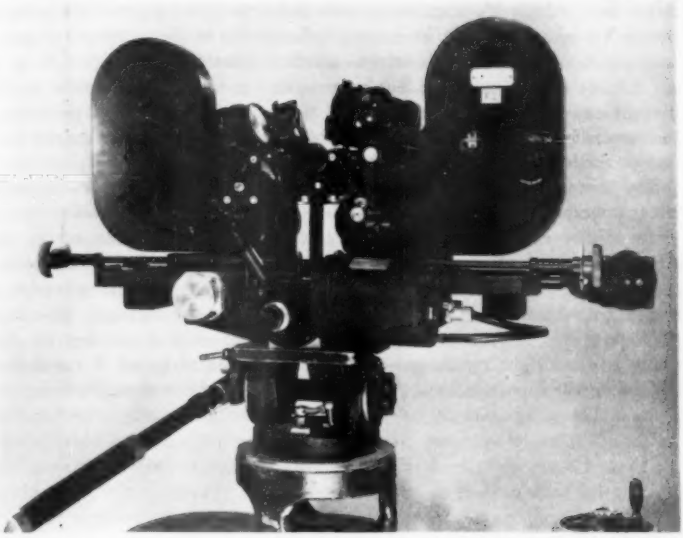
An alternative type of unit camera employs two lenses suitably placed, and immediately behind each is a rhomb prism so positioned as to direct the light beams on to the film. This system has but one advantage, the images are not reversed; but the inter-axial spacing of the lenses cannot be altered without considerable complexity and, in addition, it has all the other disadvantages of the beam-splitter method.

An alternative to the latter is the introduction of a rotary or semi-rotary mirror on the axis of the camera lens instead of the two 'inner' mirrors set at right angles to one another. This single mirror is mounted on a vertical pivot which is geared to the camera mechanism, so that at each successive exposure the mirror is facing 45° in one direction and then 45° in the other. The result is, of course, that the photographs are alternately left- and right-eye images. As will be seen later, the method is not satisfactory because it introduces excessive flicker even when the speed of the camera is increased.

The only satisfactory method of taking stereo-motion pictures is by using two cameras. Of course two separate cameras can be enclosed in a single casing and be driven by a common mechanism, but essentially, from practical considerations, two lens systems and two separate film records are necessary if we are to avoid complexity and if we are to adhere to the present dimensional and other film standards. Whilst it is comparatively simple to mount two small motion picture cameras side by side—as is done with cameras which carry film of 16mm. width or less—it is difficult to do so with the more bulky professional 35mm. cameras.* It is, therefore necessary to introduce into the optical system mirrors or prisms or the like so that small inter-axial spacing of lenses may be used. One such system employs a pellicle mirror†. One camera is placed behind the mirror and the other in front of it, but so arranged that its optical axis is at an angle of about 57° to the incident light. The inter-axial spacing of the lenses can be varied from near-zero to the limit imposed by the

* A 35mm. stereo-camera with each unit mounted side by side has been made recently for the National Film Board of Canada. The minimum lens separation is 1.95 inches.

† A pellicle mirror is one that has an extremely thin metallic surface so that it is partially reflective and partially transmissive. A mirror for stereo work must reflect and transmit light equally otherwise the density and/or the colour values of the two images will differ.



Studio Lambert

FIGURE 6: *Rear view of the Spottiswoode Spacemaster 35mm. stereo-camera, showing convergence controls, binocular view-finder and driving motor*

width of the mirror, by moving the front camera parallel to the plane of the mirror. The system has two serious disadvantages. Unless the mirror is very thin indeed it will reflect double images which will be recorded on one of the films; secondly, the light intensity reaching the films is reduced by at least one half. With the greater use of fine grain emulsions and integral tri-pack colour film stocks,* it is important that the highest possible image brightness be obtained. Adequate brightness of indoor and studio shots already presents difficulties for the lighting-cameraman.

The most practical arrangement is to place the cameras facing one another with their optical axes in one and the same straight line. In front of each lens is mounted a mirror or prism. By sliding the cameras apart, the inter-axial spacing of the lenses can be increased and *vice versa*, the minimum inter-axial being determined by the smallness of the mirrors or prisms used. Each of the cameras may be pivoted and the optical axes of the lenses may be adjustable in reference to the position of the films, so that very near objects may be taken.

A camera equipment of this type has been perfected recently by the Spottiswoode brothers and is presently being used for taking the first British stereo feature film. Perhaps it is fitting to pay tribute to these two pioneer

* Fine grain black-and-white emulsions and integral tri-pack colour stocks have speeds of about 25° and 21° B.S.I. respectively when used with artificial light.

technicians, who, with scant recognition and little or no support, have applied themselves sedulously and, let me say, successfully, to the technique of making stereo-motion pictures. This stereo-camera is illustrated in Figure 6. It has 45° mirrors integral with the lens mounts, and it incorporates a novel form of high-precision convergence mechanism that permits the relative positions of the camera units to be controlled to within 0·0005 in. The two units are driven from a single synchronous motor by telescopic shafts.

The distortion of space or depth is an ever-present difficulty in stereo-cinematography, particularly when dealing with greatly magnified images. Even if our method of photography has been precise—that is, we have orthostereoscopic images—we shall find that under ideal conditions of projection there is, at most, only one member of our audience who is able to receive the images free from space distortion. If, for instance, our fortunate observer is A (Figure 7) sitting, say, thirty feet from the screen and viewing an object whose left and right eye images fall upon the screen at L and R respectively, the object will appear to be at A_i, say, 15 feet from the screen. To observer B,

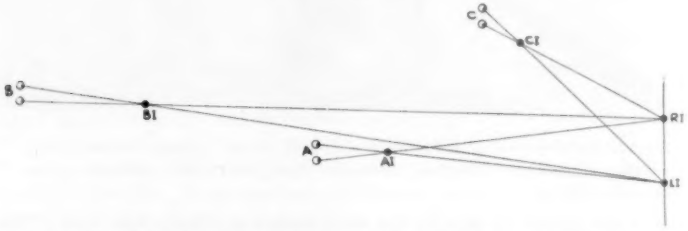


FIGURE 7: *The effect of crossed parallaxes. The left and right eye images of an object fall upon the screen at L_i and R_i respectively. To observer A, the image will appear to be at A_i, to observer B at B_i, and to observer C at C_i. Although the linear distances of objects from the screen vary with each observer, the proportional distance remains constant.*

sitting, say, 50 feet from the screen and viewing the same images L and R, the object will appear to be at B_i, which is 25 feet from the screen. To every member of our audience the apparent linear position of the object in respect of the reference plane of the screen will be different, and consequently to every observer (except observer A) there must be distortion, more or less, in the space perception of the object. It can, however, be shown that if object A_i appears to A to be one-half the distance between himself and the screen, it will appear to be half-way out to every other member of the audience. The proportional distance remains constant to all observers.

One basic difference between stereo-cinematography and other forms of the stereoscopic art is that in the former we are generally dealing with motion, either moving objects or moving cameras. This motion requires a mechanical or electro-mechanical perfection in the synchronization of the film-carrying mechanism and of the shutters of both cameras and projectors. In photographing

a moving object, a disparity of time between the exposures of each member of a stereo pair will result in a linear displacement in the record of that moving object. This linear displacement, in turn, will cause a disparity of the apparent position of the object in space. If the speeds of the cameras or projectors are not constant in respect to one another, the apparent position of the object will be uncertain, or the separation of the images may be so great that the eyes will be unable to fuse them. It has been suggested that for normal cinematograph purposes (but excluding fast moving automobiles, aeroplanes, etc.) the exposures of image pairs should be synchronized to within 1/120th second.

To overcome synchronization difficulties, several attempts have been made to carry both positive images on a single film, either with the left and right eye images succeeding one another alternatively, or with the images arranged side by side. With the former method it is difficult to overcome flicker and loss of screen luminance. With the latter method, unless a new standard for film dimensions can be agreed, the size of each photographic image must be rather more than halved. It will be remembered that the dimensions of a single photographic image on the 35mm. film is 0.825 in. by 0.6 in., and, if two images are to be placed side by side, they will become slightly less than 0.412 in. by 0.3 in. if the same proportion of pictures are to be maintained. As a consequence, our magnification factor, already very large, must be more than doubled and the luminance of the projected picture will be proportionately reduced.

An ingenious system has been developed to overcome this disability. If each photographic image can be turned through 90°, the stereo-pair can be placed side by side with a reduction of about only one-quarter of their dimensions, and the proportion of picture height to width kept to the present standard. This can be accomplished by interposing prisms in the light beam of the projectors. Of course, the magnification factor requires to be increased and there is a loss in screen luminance, but the system is of practical interest.

During the course of this lecture several references have been made to magnification factors. The fact that we have to magnify small photographic images some three or four hundred times in order to show them satisfactorily to a large audience calls for a high degree of mechanical perfection. A screen 31 feet in width is not particularly large by to-day's standards, but it represents a 450-times magnification of our photographic image. Now if the focal lengths of our camera lenses differed by one per cent and the focal lengths of our projector lenses similarly differed by one per cent (and these differences represent a fair manufacturing tolerance) then our widths of our left- and right-eye pictures would differ by over seven inches. Since our interocular spacing is only 2½ in., we could not resolve the two images. Normally the lenses must be matched to within one-quarter of one per cent.

Furthermore, to keep the two images in accurate alignment, the projectors must be maintained in a high state of accuracy. At a close viewing distance a relative vertical displacement or movement of the two images in excess of one inch will not be resolvable and at rather greater distances will cause eye strain. But to preserve this alignment, the relative displacement of the film in

the projector gate must not exceed two-thousandths of an inch. Quite apart from the vertical vibration of the projector mechanisms themselves, it must be remembered that film is passing through the gate at the rate of 92 feet per minute, or 24 picture frames per second. Thus 24 times each second a photographic image is pulled into the projector gate and held rock-steady for about 1/30th. second whilst it is being projected on to the screen. Apart from mechanical considerations, it must be borne in mind that film stock is not a rigid material; it is elastic, and it will quickly distort and buckle when subjected to the great heat that is contained in the arc-light beam.

It was mentioned earlier that the viewing of stereoscopic pictures requires each eye to be provided with its respective image. In presenting stereo-motion pictures it is necessary to project them on to a screen in order that an audience may view them. This involves a superimposition of the images, and, therefore, some means for discriminating them becomes necessary. The earliest method of projecting twin pictures was devised by Rollman in 1853, for showing stereo lantern slides. It is known as the anaglyphic method: either the left- and right-eye images are printed in red and blue-green respectively, or red and blue-green filters are placed in the light beam of the left and right projectors. If the screen images are viewed through blue-green and red glasses, each of these glasses allows only the corresponding colour to penetrate, and each eye sees only one image. Red and blue-green being complementary colours, the resulting impression is a black and white picture seen in relief. In practice, however, it is very difficult to produce a picture whose white parts are pure, as the filters do not allow the rays to pass as absolute monochromes and the two tints are not exactly complementary. Thus the resulting picture is made up of very degraded greys. It is not possible to reproduce coloured pictures by this method. The most practicable method for discrimination is the use of polarized light. Light may be regarded as an energy which travels in wave form: and in all known forms of light sources, the planes in which the energy waves travel are indiscriminate and miscellaneous. There are several methods* by which a beam of light may be intercepted by a filter or similar device, so that the light waves passing beyond the interceptor all lie in the same plane. Such light is said to be polarized and the interceptor is called a polarizer. If the beam of polarized light is intercepted by another polarizer (usually called an analyser) lying in the same plane as the beam, the light will pass through unaffected; but if the analyser is at another plane of polarization, say at 90° to the first interceptor, no light will pass beyond the analyser. If, therefore, we intercept the light beam from the 'left-eye' projector with a polarizer set in the vertical plane, and the light beam from the 'right-eye' projector with a polarizer set in the horizontal plane, it is possible for each of the observer's eyes to receive only that image intended for it and to exclude the other image, if he wears spectacles having analyser elements set in their appro-

* Light may be polarized by reflection, refraction, double refraction with absorption and by double refraction with internal reflection. Some crystals and plastic elements have a greater rigidity in one direction than in another, and as a result any wave of light passing obliquely into them is split into two portions, one having vibrations parallel to the axis of greatest rigidity and another portion having vibrations parallel to the axis of least rigidity, and therefore at right angles to one another.

priate planes. That is, if the analyser in front of the left eye is disposed vertically, the left eye will receive the left eye image only because this is polarized vertically. The left eye will not receive the other image because it is horizontally polarized. Similarly, if the analyser in front of the right eye is disposed horizontally, the right eye will receive only the right eye image and the left eye image will be excluded.

It is, of course, important that the screen does not depolarize the light which it reflects, and for this purpose the screen surface requires to be sprayed with a suitable metallic paint. This is the most convenient means for providing a non-depolarizing surface.

It will, no doubt, be inferred from this superficial survey of the problems involved in stereo-cinematography, that this form of motion picture presentation is difficult and complex. It is, of course, true that it needs new and higher standards of photography and of processing techniques. It requires greater precision in projection than the normal two-dimensional picture. It also requires the audience to wear analysing spectacles, to which some people raise objection. It is unfortunate that, due to ill-informed opinion, the public have associated the wearing of polarizing spectacles with eye strain. These spectacles are not basically different from the types of sun-glasses that have become popular within recent years and which the public willingly wears to avoid glare and consequent strain. The cause for complaint lies with the unfortunate techniques that have been used in recent films.

A question that is often addressed to me is: what is the future of the stereo-motion picture? The answer is one of public evaluation. If the public desires to see and is willing to give its support to this kind of picture presentation, I have no doubt that the film industry—which is the servant of the public—will be willing to bear the increased production and projection costs. But speaking only as a technician, I can say that the mechanical and optical complexities of the system are being overcome. It is possible to make and to project stereo-motion pictures that do not cause eye fatigue or discomfort. If the film producers can be persuaded to raise this medium from the cheap, sensational novelty type of film with which they have associated it, and apply it to the higher art-forms of the motion picture, I believe that the quality and value of the entertainment film will be much enhanced. But outside the world of entertainment, there are wide fields where the stereo-motion picture is of great value. In scientific, technological and medical researches, in geophysics and in aerial surveys, stereo-cinematography is providing a new and valuable tool.

DISCUSSION

MR. L. J. GRIFFIN: I feel that all these methods of showing stereoscopic pictures fail for this reason: they present a picture rather like a stage set with various flat scenes one behind the other; it is like looking through a child's toy theatre, and perhaps a little like the effect of a photograph taken through a telescopic lens. This was shown up particularly in the photograph of the statuette on a table, where the knee, although it appeared to come out well in front of the table, did not increase to the size it should.

This curious effect seems common to all these stereoscopic methods. Is it a matter of where one is in the cinema in relation to the focal point? Is it unavoidable? It does not seem to give a complete third dimension but rather a jerky outline with a strong subject without correct proportion of size to distance.

THE LECTURER: The effect to which the questioner refers is known as 'cardboarding'. It is due to the fact, that, in human life, when the convergence of the eyes does not give you all the information you require, you can move your head sideways, and so increase your interocular. You can 'see round the corner'. But with photographic images, this is impossible, and it is when the head is moved sideways that this cardboarding effect becomes pronounced.

The second effect to which the questioner refers arises from the fact that in viewing a real scene the effective focal length of the eye changes in relation to the distance from the observer to the various objects making up the scene. Thus there is a perspective difference in the images received of near and distant objects. When the same scene is photographed the focal length of the lens remains fixed, and consequently there are not the same perspective differences between near and far objects. When viewing the photographic image the effective focal length of the eye also remains fixed, and thus the physiological effects must be different from those caused by the real scene. The effects are the same whether the photograph is two- or three- dimensional, but probably 'cardboarding' emphasizes the effects in stereo-reproduction.

MR. J. X. PRENDERGAST: When Mr. Morris was in England recently, he said that in twelve months' time we would have stereoscopic films—that is, applied to the cinema—without spectacles.

THE LECTURER: For some years past, three-dimensional pictures have been shown in Russia by a stereoparallax system, that does not require the use of analysing spectacles. The pictures are shown in vertical strips alternating left and right images, and in front is a grid, so arranged that the left eye can see only the left eye strips and the right eye the right eye strips. The picture is seen in three dimensions. It calls for the audience to sit rigidly still—I have heard it termed 'with totalitarian rigidity'! The audience must also be very widely spaced, because in every alternate seat you get a pseudo-stereoscopic effect, that is, the right eye is seeing the left eye image, and *vice versa*. There are also other means, but they call for degrees of mechanical precision and accuracy that, at the present time, are beyond our reach.

MR. LOUIS DEMOLIN: I should like to ask if the colour saturation that is given by dyes used in the colour printing of motion pictures has any effect upon the accuracy of stereoscopy?

THE LECTURER: Yes. Colour saturation can destroy that aerial perspective which I mentioned earlier. I would be bold enough to say that colour reproduction is more important with a three-dimensional than with a two-dimensional film; and, of course, what is also very important is the colour matching of the two photographic prints, because if one is darker than the other, a very uncomfortable total impression is received.

THE CHAIRMAN: It only remains for me to express, on your behalf and on my own, our very sincere thanks to Dr. Knopp for all the thought that he has put into the preparation of this lecture. I am sure that many of us will feel that, although we have had the pleasure of hearing it, we shall have to read it when it comes out in the *Journal*, because there were so many points which it was difficult—at any rate for an average brain like mine—to grasp in the short space of time when Dr. Knopp was explaining them. I think he has shown great ingenuity in putting diagrams before us to prove his points, and altogether we have had a very interesting, extremely informative, and a very stimulating afternoon.

The vote of thanks was carried with acclamation; and, another having been accorded to the Chairman, the meeting ended.

SMUGGLERS

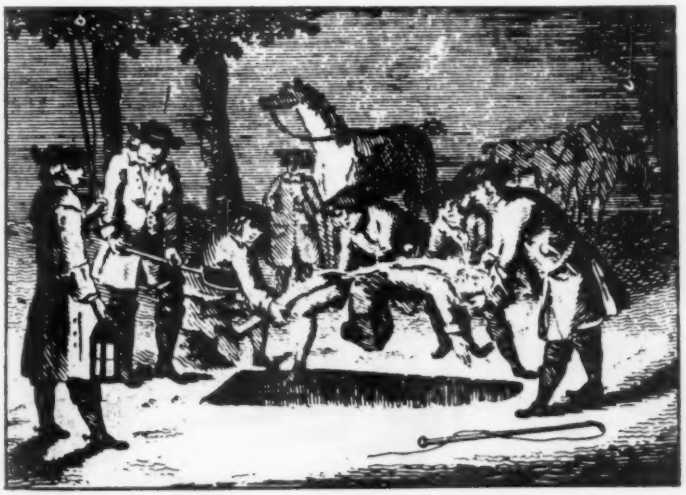
A Dr. Mann Juvenile Lecture by

RUPERT C. JARVIS, F.S.A., F.R.Hist.S.,

Librarian, H.M. Customs and Excise

Wednesday, 30th December, 1953

There is charter evidence to show that Customs duties were collected in this country at least from the eighth century. After the Norman period, the Crown frequently 'let' the Customs 'out to farm', to private individuals, corporations, or syndicates, and often to groups of foreign gold merchants, for example, to the Bardi and Frescobaldi. The fact that during part of the Middle Ages, the smuggler may thus have been doing no worse than defrauding a foreign moneylender, is probably the source of the one-time (not very creditable) tradition that it was not so very unpatriotic to be a smuggler.



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'The unfortunate William Galley put by the Smugglers into the Ground & as is generally believed before he was quite DEAD'. From a print of 1748

Having thus let the Customs out to farm, and having drawn the stipulated 'rent' for a particular port or group of ports (or indeed for the whole country), the Crown would not be concerned to maintain its own officers at the waterside. The 'smuggler' in the earlier days, may have operated by bringing his vessel into the remoter creeks; but as the organization developed, he could no longer rely upon escaping notice altogether. He would therefore have to have recourse to bribing the men whom the 'farmers' had put in to collect the Customs for them. The main reason why the smuggler could not rely upon 'running' the goods in the familiar eighteenth century fashion, was that the rig of ships before the middle of the seventeenth century, the characteristic square rig of Columbus' *Santa Maria* and Drake's *Golden Hind*, prevented them from running in on a wind and out again on the same wind.

The later seventeenth century saw three developments important for the smuggler: first, the development of the fore-and-aft rig, which enabled vessels to sail both in and out again, on more or less any wind; secondly, the engagement of England, through William of Orange, in the Continental wars, which forced up the rates of Customs duty; and, thirdly, the decision of Charles II to take the Customs finally out of farm. Thus, by reason of the technical development of rigging, smuggling was greatly facilitated; and by raising so considerably the level of duties, smuggling was much encouraged; but on the other hand, by the reorganization of the service, a disciplined force of professional Customs officers was brought into being, responsible immediately to the Crown.

Now came the tug-of-war.

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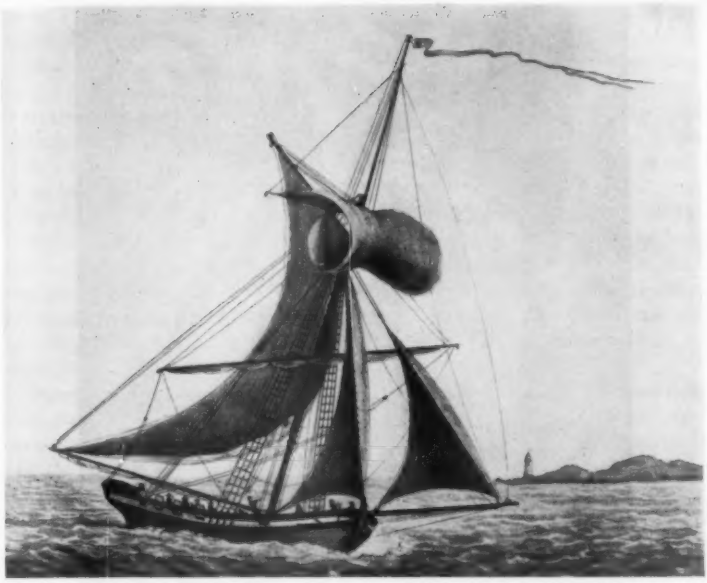
'A Representation of ye Smugglers breaking open ye King's Custom House at Poole'. From a print of 1747



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The Badger *(c. 1790), one of the most noted of the Revenue Cutters*

The Customs put a preventive service afloat, developed the 'cutter rig', and declared war on the smuggler. The main trouble was that the smuggler found his greatest profit in time of war, operating not only against the high duties, but also against the war-time restrictions and prohibitions. This was the very period when (before the time of police) fewer troops were available at home, and when the preventive service afloat would have to go off to the assistance of the Royal Navy.

The smugglers' attack on the Custom House, Poole, in 1747, the well-authenticated details of the murder of Chater and Galley in 1748, and the familiar story of 'the Hawkhurst gang', help to illustrate the desperation and violence of the smugglers who had added treason and treachery to their other crimes.

However, with the exception of such a black spot as the Isle of Man (where the case was complicated by certain curious constitutional anomalies), the traffic some time after the middle of the century was, if not suppressed, at least reduced to more manageable proportions.

Before the end of the eighteenth century, however, Britain again became

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Paradisea apoda luptoni

involved in a major war on the Continent, and it is this period of the Napoleonic wars and the years immediately following that is so beloved of the high romancers.

It is usually overlooked by the writers of fiction (especially that body of fiction which does service as 'history' in this connection) that the purely revenue offences of the smugglers of this period were the least of their crimes. It was during this period that those English smugglers whom the romancers delight in were being paid by the enemy to find a way through the British blockade. They were carrying into France British sovereigns for which Napoleon was willing to pay 27 to 28 shillings each. If they brought back their 'swag' in the form of cheap brandy, it was because French francs were not only useless to them —they were evidence of their treachery. Napoleon himself said he kept English smugglers in his pay because they brought him English newspapers through the blockade, and news of where exactly the new Martello towers were being

built. They smuggled letters to and from the spies he kept in England, and helped his spies to escape to France.

I am not going to tell you that all this was evading the contemporary exchange control regulations, that it was trading with the enemy, that it was espionage, that it was treason, that it was treachery. I was only going to say that the surviving historical records of the period show that it was not really what the fiction writers love to call glamorous. It was not really what they love to call romantic. At its best, it was just a dirty business.

By the 1830s, however, the violence and the large-scale hang-over of this traffic had been practically if not entirely suppressed. We know from the surviving but unpublished records of the period that the Customs now came to be more concerned about the 'coopering' of ships, that is to say, their structural adaptation (by way of double-bulkheads, forepeak cavities, false double-bottoms, and so forth). This itself is evidence that the smugglers could no longer rely on the older method of the direct 'run'.

Surviving evidence shows that gradually the coopering of ships became more refined and the concealed cavities smaller, that is to say the general chances of detection greater. It is at this point—the middle and end of the last century—that the characteristic smuggler becomes the passenger.

Certainly, the smuggler-on-the-person is at a great disadvantage to-day, if only by having to play against a team with more than a hundred years longer experience in the game. It is a thousand-to-one chance that the very latest method the smuggler devised yesterday, was discovered by the Customs many years ago. Its *principle* certainly was. This is almost certainly the reason why so little can be got out of the Customs—even in the courts—as to their exact methods of detection.

There are interesting aspects of smuggling besides the purely revenue ones. An example of this was the detection in 1922 (in some cases of 'eggs') of prohibited plumage—prohibited in order to preserve from extinction certain internationally agreed species of rare birds. In this instance, the seized specimen proved to be of a hitherto completely unknown sub-species of the bird of paradise, now named *paradisea apoda luptoni*, after the late Mr. A. S. Lupton, the Customs official principally concerned in the case.

OBITUARY

SIR EDGAR WATERLOW

We record with regret the death, at the age of 73, of Sir Edgar Waterlow, third Baronet, on the 12th January.

Edgar Lutwyche Waterlow joined the family printing business, Waterlow and Sons, in 1893, was joint managing director from 1914 to 1945, and chairman from 1927 to 1940. He was President of the Printers Pension Corporation Festival in 1938, and was elected a Fellow of the Society in 1934.

NOTES ON BOOKS

SCOTTISH CASTLES OF THE SIXTEENTH AND SEVENTEENTH CENTURIES. *By Oliver Hill, with an introduction by Christopher Hussey. Country Life, 1953. £6 6s*

Scotland was never conquered by its king, as the English were in 1066, and so the Scottish country districts enjoyed a large measure of local autonomy under the leadership and protection of the principal local families. In both highlands and lowlands these able families were of very mixed origin: thus, the Macleods were Norse, the Stewarts were Breton, the Dunbars were Gaels, the Clan Menzies were Norman, the Innes family were Flemish and the Maxwells were Angles. Until the seventeenth century, these leading families were organized in such a way that all their dependants eventually came to be regarded as members of the family community; lowland chiefs were as active as highland patriarchs in guarding the interests of the people of their name; and thus Scotland never knew a peasants' revolt.

The greater administrators, who were tenants-in-chief of the Crown, were called lairds. Many lairds were also barons, which meant that they had a duty to administer local customary law through duly appointed officers, and in particular a duty until 1747 of executing malefactors who had been convicted by assessors drawn from the ordinary people. From the fifteenth century onwards a few of the more important barons, like Boyd of Kilmarnock and Lyon of Glamis, were granted peerages as Lords of Parliament. But the ordinary baronage continued to function. Thus the Boswells of Auchinleck were made barons in 1504, and the Camerons of Lochiel became barons in 1528. The number of these ordinary barons was greatly increased after the Reformation in 1560, and Mr. Oliver Hill's *Scottish Castles* is about many of the baronial towers in which these lairds had their homes.

These towers were comparatively small, for it was not intended that they should stand sieges, but that their ground-plan should be so restricted as to be defended by the smallest possible number of armed ploughmen against the sudden attack of 'unthankful unnatural neighbours'. The standard work on these castles is MacGibbon and Ross's *Castellated and Domestic Architecture of Scotland*, published in five volumes between 1887 and 1892. So monumental a pioneer work could not be infallible, and a few of its minor errors are repeated in the main body of Mr. Hill's work, part two of which, headed 'The Sixteenth and Seventeenth Centuries', is reasonably enough based largely on MacGibbon and Ross.

This also leads Mr. Hill to make occasional out-of-date statements. Thus the race of Menzies is gone from Weem and holds Castle Menzies no more, nor is it still 'nearly 700 years' since the Maitlands acquired Thirlestane in 1228. However, he adds much new information about some of the castles, such as Cawdor, and precedes these useful notes with a most interesting chapter headed 'Origin and Characteristics'. This contains a telling phrase about the white corbelling at Allardyce recalling 'the fantastic beauty of Arab work', which will henceforward make this reviewer look with a new eye at many Scots castles.

In part three Mr. Hill follows up the main body of his work with two further chapters in the best tradition of *Country Life*. 'Decoration and Equipment' is packed with otherwise inaccessible information about Scots plenishings and interior decoration, while a delightful chapter on 'Contemporary Life' rambles charmingly from highland dress to fairies, by way of barley broth and the Glamis jester's cap-and-bells. It may be noted that both chapters contain a great deal about the highlands although most of the castles illustrated are in the lowlands, but this is perhaps because the feudal-patriarchal way of life associated with these towers lasted for a century longer among the mountain folk.

Few people know much about Scottish history, and most of those few derive their information from Victorian writers rather than from original sources, although there are Englishmen like Professor W. Croft Dickinson who possess an unsurpassed knowledge of Scotland's past. It is not generally realized, for instance, that the bulk of the population, whether highland or lowland, is Celtic in origin, except in the small Teutonic province of Lothian—and the long clash between the Irish culture of the kingdom of the Isles and the French culture of the kingdom of Scots has led to much inaccurate modern generalization that would divide Scotland too sharply into Celtic highland clans and Teutonic lowland burghers.

It was therefore difficult for so busy a man as Mr. Christopher Hussey, distinguished though his active mind is, to attempt to 'pot' unruly Scots history for this architectural work. It is not so much that his generalizations are surprising—in what way did Flodden 'break the power of the nobles'?—as that he has been misled in his premises. For instance, the flourishing Scots Parliament was not 'revived in 1688', nor was Flodden fought within several years of James IV's Tudor marriage. Again, the Tudors had as much claim to the throne of Byzantium as to that of Scotland, and the infant Mary Queen of Scots' heirs were the Hamiltons. Yet he writes that 'the twenty years' minority of the baby Queen were dominated by the fact that her next heirs to the throne of Scotland were Henry's children'. It may seem pedantic to cavil at the King Consort Henry being called 'the Earl of' Darnley or at Claverhouse being called 'the Marquess of' Dundee—but it is strange to find Thomas Cochrane, perhaps Scotland's best-known fifteenth century architect, being called 'Cockburn'.

However, it seems rather unfair to blame someone who appears to have received such shoddy help from Scots publications. A map of 'the Clan Areas of Scotland', which he reprints from a modern Scottish historical atlas, excludes Douglas, Hepburn, Kerr, Cunningham, Hay, Ogilvy, Drummond, Colqhoun, Erskine and Montgomerie although it includes Bethune, Elliot, Crawford, Macnab and Macfie. It places the Seton sphere of influence in territory actually dominated by the apparently unmentionable names of Bruce and Wemyss; and contains just enough wheat among the chaff to be thoroughly misleading to any student of Scots history.

All the same, overmuch criticism of those few pages of *Scottish Castles* that are devoted to Scots history would give an unfair emphasis to that part of this review. Primarily, *Scottish Castles* is a well annotated collection of superb photographs taken for *Country Life*, and these beautiful photographs are nowhere else accessible in such a handy and well presented form. After reading through *Scottish Castles* and examining each photograph in turn with that feeling of happy leisure and pleasured interest that Mr. Hussey's and Mr. Hill's work in *Country Life* always inspires in him, this reviewer's main regret is that he is required to return his review copy to the Society's Library.

IAN MONCREIFFE OF EASTER MONCREIFFE

FROM THE JOURNAL OF 1854

VOLUME II. 20*th January*, 1854

From the report of the discussion which followed the reading, by C. T. Judkin, *of a paper*
On Stitching Machines

Mr. Elliott thought that though it could not be said the machine would do everything, it would be a great practical blessing to this country. He believed it required a real artist in sewing to make a button-hole, and that there were as few really good workers as really good writers. The object which it appears to him would be effected by Mr. Judkin's machine would be the putting down of the low, coarse, and cheap labour, and temporarily throw out of employment those who could only

get 6*d*., 8*d*., or 10*d*., a day for their work. A great deal had been said about the badness of the pay of this class of needlewomen, but he believed they had been generally paid as much as they were worth—as their work was of such a nature that no good housewife would have it in her house. It would be far better for this class of persons to be forced to look for some outdoor employment, where, if she earned no more, she might get a little strength in her limbs and a little colour in her cheeks. A large number of these sempstresses were married and, however strange it might appear to say so, he believed that it would be for their own benefit and that of society, if they were thrown out of employment altogether—as the husband would then bring home more of his own earnings, and the wife would be properly employed in economising the money. The best state of society was that in which the woman did not earn any money, but where the husband worked, and the wife was employed in making the 8*s*. or 10*s*. go to the utmost extent in making a comfortable home, and in exercising her natural talents in the development of domestic virtue and economy. He considered Mr. Judkin, and the inventors of all similar machines, as benefactors of society; and if any one could invent a washing machine which would take in the dirty linen at one end and send it out ready for wear at the other, he would be deserving of the highest honours, as there was no worse kind of labour, or one more subversive of all domestic happiness, than washing.

Some Activities of Other Societies and Organizations

MEETINGS

MON. 25 JAN. Electrical Engineers, Institution of, Savoy Place, W.C.2. 5.30 p.m. *Should Sound Broadcasting of the Future be entirely in the V.H.F. Band?* (Discussion.)

Geographical Society, Royal, S.W.7. 5.30 p.m. *Land of the Long Day* (Film).

TUES. 26 JAN. Caroline Haslett Trust, at the Institution of Electrical Engineers, Savoy Place, W.C.2. 6 p.m. Miss E. J. Sharp: *Western Germany To-day: Electricity for the Home.*

Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. C. A. Risbridger and W. H. Godfrey: *Rainfall, Run-Off, and Storage—Elan and Claerwen Gathering Grounds.*

Illuminating Engineering Society, at the Lighting Service Bureau, 2 Savoy Hill, W.C.2. 6 p.m. *Design of Lighting Fittings* (Discussion).

Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester, 3. 6.30 p.m. G. L. Davies: *The Problem of the Western Isles.*

WED. 27 JAN. British Foundrymen, Institute of, at the Waldorf Hotel, W.C.2. 7.30 p.m. A. Adam: *Cast Iron apropos Enamelling.*

British Kinematograph Society, at G.B. Theatre, Wardour Street, W.1. 7.15 p.m. Eric Robinson: *The Technique of Music for Television.*

Victoria & Albert Museum, South Kensington, S.W.7. 6.15 p.m. Margaret Medley: *An Introduction to Chinese Porcelain.*

Wood Education Society, at the Royal Society of Arts, W.C.2. 7 p.m. H. Lemon: *The History of Spinning.*

FRI. 29 JAN. Mechanical Engineers, Institution of, Storey's Gate, S.W.1. 5.30 p.m. D. Firth and Leslie Young: *Some Model Experiments on Special Control Valves.*

SAT. 30 JAN. Chemical Engineers, Institution of, at Birmingham University. 2.30 p.m. B. Edgington: *Some Aspects of Biochemical Engineering.*

Horniman Museum, Forest Hill, S.E.23. 3.30 p.m. A. A. Bake: *Hobby-horses and Other Folk-lances in Southern India.*

MON. 1 FEB. Geographical Society, Royal, S.W.7. 8.15 p.m. H. Harrer: *Seven Years in Tibet.*

TUES. 2 FEB. Chemical Engineers, Institution of, at the Geological Society, Burlington House, W.1. 5.30 p.m. J. F. Richardson and W. N. Zaki: *Sedimentation and Fluidisation.*

Civil Engineers, Institution of, Great George Street, S.W.1. 5.30 p.m. M. J. Tomlinson: *Site Exploration for Maritime and River Works.*

Manchester Geographical Society, 16 St. Mary's Parsonage, Manchester, 3. 6.30 p.m. Rev. T. Malam: *Greek Interlude.*

Textile Institute, at 10 Blackfriars Street, Manchester, 3. 7 p.m. W. A. Allen: *Factory Design for Textile Manufacture.*

WED. 3 FEB. British Kinematograph Society, at G.B. Theatre, Wardour Street, W.1. 7.15 p.m. M. L. Meeussen: *The Gevacolor Duplicating Process.*

Victoria & Albert Museum, South Kensington, S.W.7. 6.15 p.m. G. W. Digby: *Meaning and Symbol in William Blake*—(1) *The Gates of Paradise.*

THURS. 4 FEB. Engineering Inspection, Institution of, at the Royal Society of Arts, W.C.2. 6 p.m. G. W. Preston: *Copper and its Applications, with Particular Reference to the Activities of the Copper Development Association.*

Metals, Institute of, 4 Grosvenor Gardens, S.W.1. 6.30 p.m. R. W. Douglas: *Germanium and Silicon.*

SAT. 6 FEB. Horniman Museum, Forest Hill, S.E.23. 3.30 p.m. M. Freedman: *Death and Marriage Among Chinese in Singapore.*

OTHER ACTIVITIES

WED. 27 JAN. Building Centre, 26 Store Street, W.C.1. 12.45 p.m. Film Show: *Hairians Works; Hairians Paints.*

WED. 3 FEB. Building Centre, 26 Store Street, W.C.1. 12.45 p.m. Film Show: *Building in Stone.*

NOW UNTIL 6 FEB. Beaux Arts Gallery, Bruton Place, W.1. Exhibition: *Paintings and Drawings by Justin Pieris Daraniyagala.*

NOW UNTIL 7 FEB. Tate Gallery. Exhibition: *Paintings and Drawings by Raoul Dufy.*

NOW UNTIL APR. Victoria & Albert Museum, S.W.7. Exhibition: *Bazaar Paintings from Calcutta.*